

WHAT IS CLAIMED IS:

1. A method of stabilizing the mean wavelength of light generated by a superfluorescent fiber source (SFS), the method comprising:

providing the SFS, the SFS comprising:

an Er-doped fiber (EDF) having a first end, a second end, and a length between the first end and the second end;

a coupler optically coupled to the first end of the EDF;

a pump source optically coupled to the coupler, the pump source producing pump light, the mean wavelength influenced by a wavelength of the pump light, the wavelength of the pump light dependent on the temperature of the pump source and dependent on the power of the pump light, the pump light propagating to the EDF via the coupler, whereby the EDF responds to the pump light by producing forward amplified spontaneous emission (ASE) light propagating away from the pump source and backward ASE light propagating towards the pump source;

a mirror optically coupled to the coupler, whereby the mirror reflects the backward ASE light as reflected ASE light, which propagates to the EDF, the reflected ASE light amplified upon travelling through the EDF, the forward ASE light and the amplified reflected ASE light propagating out of the second end of the EDF; and

an optical isolator coupled to the second end of the EDF, the forward ASE light and the amplified reflected ASE light from the second end of the EDF being transmitted through the optical isolator as the SFS output light;  
optimizing the length of the EDF;

and

reducing the influence of the pump light wavelength on the stability of the mean wavelength.

2. The method of Claim 1, wherein the method further comprises reducing variations of the temperature of the EDF.

3. The method of Claim 1, wherein the method further comprises estimating variations of the mean wavelength due to variations of the temperature of the EDF.

4. The method of Claim 1, wherein optimizing the length of the EDF comprises selecting the length to compromise between reduction of the dependence of the mean wavelength on the pump light power and reduction of the contribution of the forward ASE light to the output light.

5. The method of Claim 1, wherein reducing the influence of the pump light wavelength on the stability of the mean wavelength comprises reducing variations of the temperature of the pump source.

6. The method of Claim 1, wherein reducing the influence of the pump light wavelength on the stability of the mean wavelength comprises tuning the pump source to a wavelength at which a first-order dependence of the mean wavelength on the pump light wavelength is small or substantially zero.

7. A superfluorescent fiber source (SFS) to generate output light having a mean wavelength with a selected stability, the SFS comprising:

an Er-doped fiber (EDF) having a first end, a second end, and a length between the first end and the second end;

a coupler optically coupled to the first end of the EDF;

a pump source optically coupled to the coupler, the pump source producing pump light, the mean wavelength of the output light influenced by a wavelength of the pump light, the wavelength of the pump light dependent on the temperature of the pump source and dependent on the power of the pump light, the pump light propagating to the EDF via the coupler, whereby the EDF responds to the pump light by producing forward amplified spontaneous emission (ASE) light propagating away from the pump source and backward ASE light propagating towards the pump source;

a mirror optically coupled to the coupler, whereby the mirror reflects the backward ASE light as reflected ASE light, which propagates to the EDF, the reflected ASE light amplified upon travelling through the EDF, the forward ASE light and the amplified reflected ASE light propagating out of the second end of the EDF; and

an optical isolator coupled to the second end of the EDF, the forward ASE light and the amplified reflected ASE light from the second end of the EDF being

transmitted through the optical isolator as the output light, whereby the stability of the mean wavelength of the output light is selected by optimizing the length of the EDF and reducing the influence of the pump light wavelength on the mean wavelength.

8. The SFS of Claim 7, wherein the stability of the mean wavelength of the output light is further selected by reducing variations of the temperature of the EDF.

9. The SFS of Claim 7, wherein the stability of the mean wavelength of the output light is further selected by estimating variations of the mean wavelength due to variations of the temperature of the EDF.

10. The SFS of Claim 7, wherein the selected stability is within approximately  $\pm 0.5$  part per million over a period of time of at least one hour.

11. The SFS of Claim 7, wherein the selected stability is within approximately  $\pm 0.5$  part per million over a period of time of at least 17 hours.

12. The SFS of Claim 7, wherein the EDF has a small-signal absorption of at least approximately 340 decibels.

13. The SFS of Claim 7, wherein the pump source comprises a laser diode having a temperature and a laser diode current, whereby the temperature is controllable to be stable within approximately  $\pm 0.01$  degree Celsius and the laser diode current is controllable to be approximately 10 microamps.

14. The SFS of Claim 7, wherein the coupler comprises a wavelength-division multiplexer.

15. The SFS of Claim 14, wherein the wavelength-division multiplexer has a polarization-dependent loss (PDL) less than approximately 0.01 decibel.

16. The SFS of Claim 7, wherein the SFS has no polarization controller.

17. A method of determining an estimated mean wavelength of a superfluorescent fiber source (SFS), the method comprising:

providing an SFS having an actual mean wavelength, the SFS comprising an erbium-doped fiber (EDF) having a temperature and a pump source;

configuring the SFS such that the actual mean wavelength has a dependence on the temperature of the EDF;

obtaining the dependence of the actual mean wavelength on the temperature of the EDF;

measuring the temperature of the EDF; and

calculating the estimated mean wavelength using the measured temperature of the EDF and the dependence of the actual mean wavelength on the temperature of the EDF.

18. The method of Claim 17, wherein the pump source has a temperature and an input current, and the step of configuring the SFS comprises:

controlling the temperature of the pump source;

controlling the input current of the pump source; and

reducing polarization-dependent losses by omitting polarization controllers from the SFS.

19. The method of Claim 18, wherein the estimated mean wavelength is within approximately  $\pm 0.05$  part per million of the actual mean wavelength over a period of time of at least 17 hours.

20. The method of Claim 18, wherein the estimated mean wavelength is within approximately  $\pm 0.05$  part per million of the actual mean wavelength over a period of time of at least one hour.

21. The method of Claim 17, wherein obtaining the dependence of the actual mean wavelength on the temperature of the EDF comprises varying the temperature of the EDF and measuring the corresponding actual mean wavelength, and calculating a best-fit straight line of the actual mean wavelength to the temperature of the EDF.

22. The method of Claim 17, wherein the SFS has a double-pass configuration.

23. The method of Claim 17, wherein variations of the actual mean wavelength are primarily due to variations in the temperature of the EDF.

24. The method of Claim 17, further comprising controlling the temperature of the EDF to be stable to within approximately  $\pm 0.5$  degree Celsius.

25. The method of Claim 17, wherein measuring the temperature of the EDF comprises measuring an ambient temperature and assuming that the temperature of the EDF is approximately equivalent to the measured ambient temperature.

26. The method of Claim 17, wherein obtaining the dependence of the actual mean wavelength on the temperature of the EDF comprises measuring the dependence of the actual mean wavelength on the temperature of the EDF.

27. The method of Claim 17, wherein obtaining the dependence of the actual mean wavelength on the temperature of the EDF comprises obtaining the dependence of the actual mean wavelength on the temperature of the EDF from another source.

28. A superfluorescent fiber source (SFS) having a mean wavelength which is stable to within approximately  $\pm 0.5$  part per million over a period of time of at least one hour.

29. The SFS of Claim 28, wherein the mean wavelength is stable to within approximately  $\pm 0.5$  part per million over a period of time of at least 17 hours.

30. The SFS of Claim 28, wherein the SFS has a double-pass configuration.

31. The SFS of Claim 28, wherein the SFS comprises an erbium-doped (Er-doped) fiber having a temperature.

32. The SFS of Claim 31, wherein variations of the mean wavelength are primarily due to variations in the temperature of the Er-doped fiber.

33. The SFS of Claim 32, wherein the temperature of the Er-doped fiber is controlled to be stable to within approximately  $\pm 0.5$  degree Celsius.

34. A superfluorescent fiber source (SFS) that generates output light having a mean wavelength with a selected stability, the SFS comprising:

an erbium-doped fiber (EDF) having a length disposed between a first end and a second end, a temperature;

a pump source controlled to produce pump light at a substantially constant pump wavelength, the mean wavelength of the SFS influenced by the pump wavelength, the pump wavelength dependent on the temperature of the pump source and dependent on the power of the pump light, the pump light coupled to the first end of the EDF to propagate toward the second end of the EDF, the EDF responsive to the pump light to produce forward amplified spontaneous emission (ASE) light that propagates toward the second end of the EDF and is output from the second end of the EDF, the EDF further responsive to the pump light to produce backward ASE

light that propagates toward the first end of the EDF, the backward ASE light having a first polarization; and

a mirror optically coupled to receive the backward ASE light, the mirror reflecting the backward ASE light to produce reflected ASE light at a second polarization orthogonal to the first polarization, the reflected ASE light coupled to the first end of the EDF and amplified upon propagating through the length of the EDF to the second end of the EDF where the amplified reflected ASE light is output with the forward ASE light, whereby the stability of the mean wavelength is selected by optimizing the length of the EDF and reducing the influence of the pump wavelength on the mean wavelength.

35. The SFS of Claim 34, wherein the stability of the mean wavelength is further selected by reducing variations of the temperature of the EDF.

36. The SFS of Claim 34, wherein the stability of the mean wavelength is further selected by accounting for variations of the temperature of the EDF.

37. The SFS of Claim 34, wherein the selected stability is within approximately  $\pm 0.5$  part per million over a period of time of at least one hour.

38. The SFS of Claim 34, wherein the selected stability is within approximately  $\pm 0.5$  part per million over a period of time of at least 17 hours.